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ABSTRACT

Supplemental Course Instruction (SCI) at Olivet Nazarene University is described as a program in which a high achieving student retakes a course successfully completed in order to model desired behaviors for other students. The SCI Leader demonstrates good study skills and organizes small group study sessions. This study examines the effectiveness of the SCI program. Confounding factors such as the voluntary nature of the study sessions and the open admission policy of the college were controlled through structural equation modeling. Structural equation modeling requires that all of the hypothesized relationships between the variables be posited in advance. A total of 461 students enrolled in four freshman-level courses were surveyed, with complete data being obtained for 253 cases which were used in the structural equation analysis. The analysis studied: (1) the effect of factors affecting SCI participation, such as high school rank, marital status, semester load, and expected grade; and (2) the effects of SCI participation on course grade, semester grade point average, and re-enrollment. The study found that the more a student is "at risk" the more likely he or she is to use SCI. The study also found a positive impact of SCI participation on course grade. There were direct effects of SCI on grade point average, suggesting the transfer of study skills learned. (10 references) (JDD)

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SEPARATING THE WHEAT FROM THE CHAFF: FINDING THE UNIQUE EFFECT OF SUPPLEMENTAL COURSE INSTRUCTION

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Olivet Nazarene University

Presented at the 11th Annual Conference of the National Association for Developmental Education New Orleans, March 6, 1987

Supplemental Course Instruction at Olivet Nazarene University

Supplemental Course Instruction is a program adapted from the Supplemental Instruction program at University of Missouri at Kansas City. SCI is an attempt to instill in students the appropriate behaviors for success in a particular course by modeling those behaviors. Information about the program at UMKC can be found in various sources which are cited in Martin et. al. (1983).

In SCI, an undergraduate student is selected from among students who have made an A in a given course and have shown an ability to communicate with their peers. This person, called an SCI leader, models desired behaviors while retaking the course. The SCI leader demonstrates good study skills in the classroom by taking good notes, not sleeping, asking the right kinds of questions, etc..

The leader also organizes study sessions. Study sessions are held twice a week for about an hour at a time. Attendance is

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voluntary. During the study session, the leader directs a review of course material by reviewing notes, discussing textbook material, trying to help the students discover for themselves what may or may not be on a test, directing the group in writing a possible test, and using other techniques described in the materials from the Supplemental Instruction program at UMKC.

Our purpose in having SCI is to provide as much assistance to students as possible, in a cost efficient way, and to help students identified upon entry as marginal or perhaps high risk. We also hope to help low risk freshmen to increase the likelihood of a successful first year and thereby to increase the possibility of their retention. We believe that if a student can find success in one class and learn better study skills in that class then the skills learned through SCI will transfer to other courses.

The reason for writing this paper is to examine the effectiveness of SCI in light of its stated purpose. After controlling for the confounding effects of marital status, age, high school rank, and ACT scores, what is the actual effect of attending the SCI study sessions on course grade, semester grade point average and reenrollment? All these variables are interrelated and it is difficult to say what the effect of each individual variable may be. A secondary focus of this paper is on the use of structural equation modeling as a means of describing the relationship of the variables.

Evaluating Program Effectiveness

One concern in evaluating a program is to show what the institution would be like if the program did not exist. Hopefully, one proves that the institution is different due to the program and that the difference is for the better. This positive effect will supposedly lead to continued and, perhaps, increased funding.

A more idealistic concern in evaluation is to provide direction for the program. Does there need to be modification? Should there be an expansion of services or maybe a reduction?

Our intent is to show that SCI is worth the time, money, and effort. We want to show that there is a direct impact on the student who attends SCI and that that impact is seen in better grades and continued enrollment.

Most program evaluations are done using some variation of an experimental model. As William Cooley (1978) points out, this is particularly true within education. Using specified outcome measures, a population that has participated in the program is compared with a population that has not. It is then assumed that any differences between the "experimental" and "control" groups are due to the effect of the program. The outcomes measures are then submitted to certain statistical tests (t-test, analysis of variance) to see if the differences that are observed are "real".

The true experimental model is a very powerful explanatory tool. This is true because it has the power to control all the variables affecting the experimental and control groups except the treatment effect. Because these two groups are equivalent (either due to matching or random assignment) all differences must be attributable to the treatment effect. However, very rarely in the social sciences do we have the luxury of equivalent groups. Only carefully designed psych labs approximate this. In education, we quickly move away from the experimental ideal. Not only are we working with groups that are not quite equivalent, but the groups vary in a number of ways that can have a direct bearing on the effectiveness of the program. Because of these and other problems, Cooley calls for us to see

> educational treatments as multi-dimensional domains, and not as distinct, discrete, homogeneous treatments worthy of comparison as levels in a typical analysis of covariance contrast" (1978, p. xxiv).

These considerations must be kept in mind whenever a program like SCI is evaluated.

There are a number of factors that affect the success of SCI. First of all, students are not required to attend the study sessions. This means that only students who are motivated to put out the extra effort will regularly attend sessions. Because these students may have done well in the course anyway, they may receive little direct benefit from the program. Another

confounding factor is that these sessions are usually held in the late afternoon or in the evening. This fact may make it difficult for nonresident students to participate in the program. A third confounding factor is an open admission policy. Because we admit students who might be considered "marginal" or high risk, it makes it difficult to tell whether to what degree a program benefits these students. If we had a perfect experimental model, all of the relevant factors would be controlled. Nothing would vary except participation in SCI. This, however, cannot be done. What can be done, though, is to control these factors statistically. This is the singular strength of structural equation modeling.

The Logic of Structural Equation Modeling

In the same way that the classical experimental model is really an exercise in design logic, structural equation modeling is first of all a logical statement. As Anderson and Evans (1974) define it, structural equation modeling begins

> with a statement of a verbal theory that makes explicit the relationships that are hypothesized among a set of variables as well as the causal sequence thought to exist among them (p. 30).

It is only after the logical elements of the model have been assembled and defended that the statistical work can be done to "test" the model.

This logical model of the phenomena being observed begins with the specification of what variables affect the dependent variable. These may be variables that are completely inside the model or those that are outside the model. The key differences between these types of variables is time order or sequencing. Factors which exist prior to the model (age, social class) are exogenous. No attempt is made to explain why they may vary. They are simply accepted as background variables. Factors which occur slightly before the dependent variable are endogenous. We will attempt to explain their variance as a result of other variables in the model.

In a properly designed structural equation model, all of the hypothesized relationships between the variables are posited in advance. This is why it is a logical exercise. As Blalock (1964) puts it, "the basic dilemma ... is that of how much to oversimplify reality". What is actually tested statistically is the validity of the hypothetical model created. There are an infinite number of models possible. The selection of one model over another is due to the plausibility of the relationships within it. As a result, the hypothetical model must be created with great care.

If the model is specified properly, and certain a priori assumptions hold, the model can be tested with the use of least squares regression. Estimates of the effects of exogenous and endogenous variables on the dependent variable can be computed (as well as the effects of those variables on other endogenous

variables). The magnitude and direction of these estimates can then be compared with the original model to determine its validity.

This approach allows the researcher to determine the unique direct and indirect effects of all of the variables in the model. If the hypothetical model is not supported, it can be revised and the process begun again. Results obtained can then be related to certain policy decisions. Certain assumptions regarding the program in question may have to be withdrawn or reevaluated. New factors, previously thought to be insignificant, may deserve attention.

The logic of structural equation modeling makes it possible to estimate the factors that are thought to cause a certain program to succeed and then test to see if those factors really are important. However, the largest task is to create the model in the first place.

A Tentative Model of the Effects of SCI Participation

If the SCI program accomplishes its objectives, participating students should show an increase in course grade, semester grade point average, and reenrollment. The models being tested (see Figures 1 and 2) put SCI participation at a pivotal point in the causal order between individual background characteristics and these outcome measures. It must be remembered that this

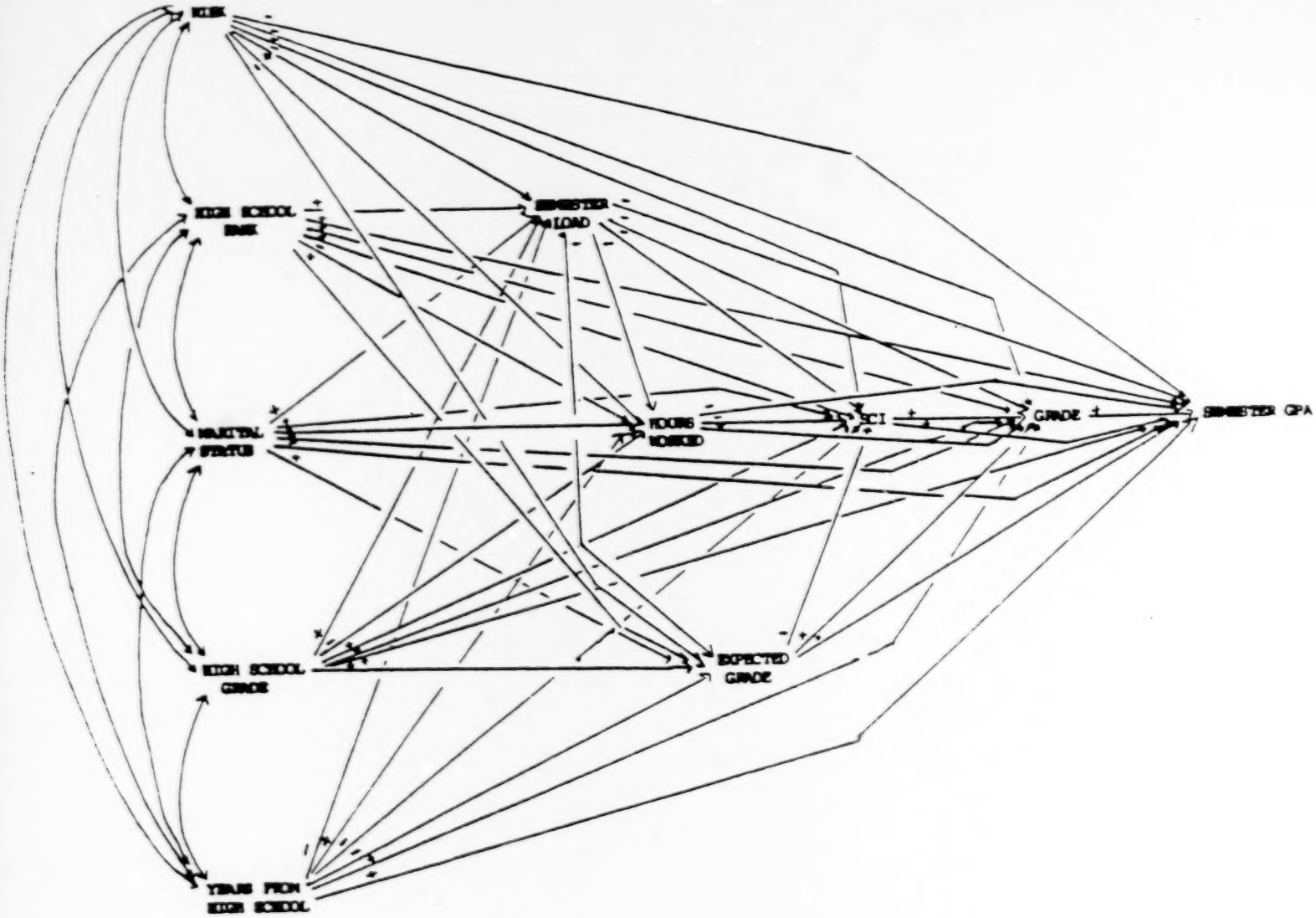

SEX
HIGH SCHOOL RANK
SEMESTER LOAD
MARITAL STATUS
HOURS ATTEMPTED
SCI
GRADE
SEMESTER GPA
HIGH SCHOOL GRADE
EXPECTED GRADE
YEARS FROM HIGH SCHOOL

FIGURE 1

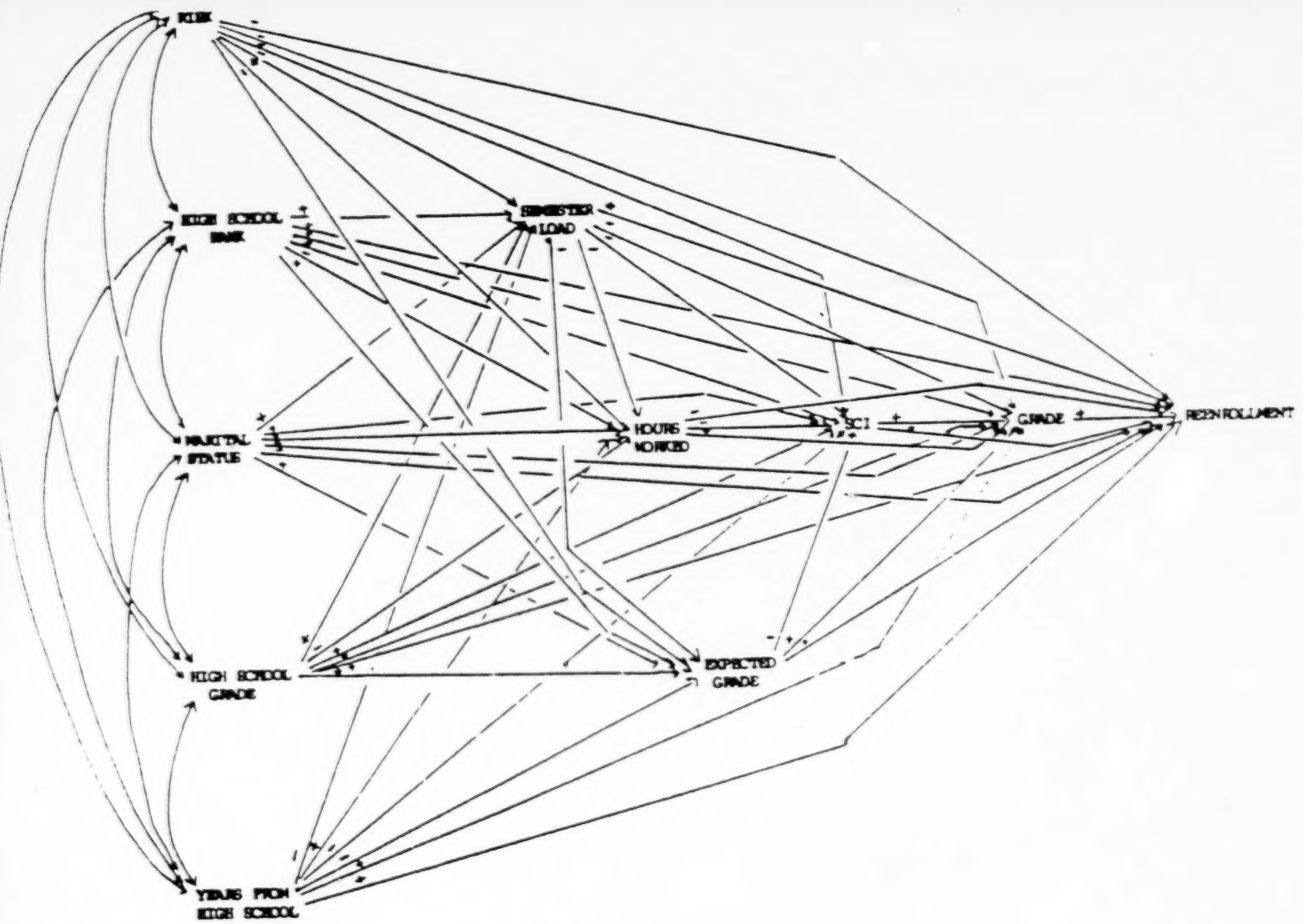

RISK
HIGH SCHOOL RANK
SEMESTER LOAD
MARITAL STATUS
HOURS WORKED
SCI
GRADE
REENROLLMENT
HIGH SCHOOL GRADE
EXPECTED GRADE
YEARS FROM HIGH SCHOOL

FIGURE 2

is only one of an infinite number of models that could be tested. The rationale for the focus on SCI is that we are interested in program evaluation. As a result, we need to be able to highlight the impacts of the program. The more specific rationales for the hypothesized relationships follow. The dependent variables will be discussed first, followed by the exogenous variables and then the endogenous variables.

Dependent Variables. Technically, only two of the outcome measures, semester GPA and reenrollment, are treated as dependent variables. Course grade will be discussed later as an endogenous variable which affects both of these dependent measures.

Exogenous Variables. There are a set of factors, occurring prior to college enrollment, which should significantly affect college performance (see Grant and Hoeber, 1978). These factors can be further divided into two groups, one group dealing with academic prowess and the other dealing with individual background characteristics. The first group of variables includes high school performance (measured by reported grades and class rank) and a risk factor computed from ACT scores. The second group includes variables of age (measured as number of years since high school) and marital status.

The endogenous variables will be affected by these "earlier" factors. The better the student was in high school, the more likely he will be to expect success in college coursework. This may make it more likely for the student to

enroll for a heavier load. The student will also be more likely to predict high achievement in any particular class. In addition, the success in high school will be related to the availability of scholarship money and therefore the student's level of employment. These low risk students will be less likely to see extra programs (like SCI) as beneficial but will still perform at a higher level than students who were less prepared. As a result, the models hypothesize that the low risk, successful high school students will, a) take heavier loads, b) be less likely to work, c) expect better grades, d) be less likely to participate in SCI, e) achieve (both in course grade and semester GPA) at a higher level, and f) be more likely to enroll in school in subsequent semesters than higher risk, less successful students.

Students who are older or are married may feel less confident about the college setting. This may cause them to take longer to complete their education, taking fewer hours per semester. In addition, the older the student, the more likely she would be to work. These added time pressures may cause lower expectations of performance and make participation in programs like SCI difficult. However, these older students may have an added incentive to achieve that often motivates them even if they do not match the image of the traditional student. This motivation can result in higher performance levels and continuation in the college program. Compared to the traditional resident student, we would expect older or married students to

a) take lighter loads, b) be more likely to work, c) have lower initial grade expectations, d) be less likely to participate in SCI, e) achieve (both in course grade and semester GPA) at a higher level, and f) be more likely to enroll in school in subsequent semesters.

Endogenous Variables. Relationships can also be hypothesized among the endogenous variables. There are five endogenous variables: semester load, hours worked, expected course grade, SCI participation, and achieved course grade. Not only do each of these relate to the dependent variables, but some relate to other endogenous variables as well.

The more hours a student takes during a semester, the less likely he is to be employed. In addition, an increase in course load may result in time management problems, forcing the student to "aim" for a lower grade in the course and to declare extra-course programs as unaffordable luxuries. Having a heavier course load could result in lower course grades and therefore lower semester GPAs. However, because additional hours taken reflect an increased commitment to the institution, there should be a positive effect on reenrollment.

The same logic would apply with respect to the effect of working. The more a student works, the more time pressures would cause conflicts. This would result in the same predictions for expected grade, SCI participation, course grade, and GPA. One difference from that described above is that the student's employment is a result of financial pressures, working a large number of hours may be related to lower rates of reenrollment.

The more a student expects to succeed in a course, the more likely she is to do so. There should be a direct relationship between expected grade and achieved grade. There should also be a direct relationship between expected grade and both of the dependent variables. The exception to this positive pattern may relate to SCI participation. The more a student feels like she may have trouble with a particular class, the more she may feel the need for an extra program like SCI. Thus, there should be a negative relationship between expected grade and SCI participation.

As stated earlier in this paper, the goals of SCI are to assist the student in developing study skills for a particular course as well as to increase the likelihood of success in college generally. To the extent that it achieves these goals, we would expect SCI participation to be positively related to course grade, semester GPA, and to subsequent reenrollment.

Obviously, the performance of a student in an individual class will impact his semester GPA. This is due to the simple arithmetic of the GPA calculation. In addition, success in individual classes should result in positive feelings regarding college that make retention more likely.

The hypothetical relationships described above may not be held by all developmental educators. However, we see the model as a plausible image of what factors may affect college performance. This model allows a clear test of the impact of SCI

participation while controlling for the confounding effects that are always present in evaluating student performance.

The Data

The data includes the following variables:

(1) years since high school.
(2) high school grade point average (self reported).
(3) marital status.
(4) current semester load.
(5) hours worked.
(6) expected course grade (at the beginning of the semester).
(7) number of SCI sessions attended (self reported).
(8) course grade.
(9) semester grade point average.
(10) risk factor (high, moderate, or low, depending on ACT score).
(11) High School class rank.
(12) reenrollment data for the following two semesters.

Two questionnaires were distributed during the Fall semester of 1985. The first questionnaire, given during the first week of classes, requested variables (1) through (6), as well as name, identification number and times the student would prefer for the sessions to be held. The second questionnaire, distributed during the last week of classes, requested information (7) as well as the degree of helpfulness of the sessions, their expected grade, comments, and if the student did not attend review sessions, why. Data (8) through (12) came from the registrar's records.

The courses associated with SCI during the Fall of 1985 were

Introduction to Sociology, Introduction to Psychology, Math for General Education, General Zoology, and Introduction to Chemistry. These courses are freshman level courses that meet general education requirements for graduation. The General Zoology and Introduction to Chemistry courses have a large percent of nursing majors.

The data used in this analysis do not include the students in General Zoology. This course was not included for several reasons. First, the SCI program depends on the SCI leader having had the professor before and the Zoology course was taught by a first-time instructor. Second, even though there was a large percentage of nursing majors in the class, they were unable (ostensibly due to schedule conflicts) to participate in the SCI sessions. Third, there are certain statistical problems (principally multicollinearity) with the data from General Zoology. These problems make interpretation of the data from that course nearly impossible.

The number of students enrolled in the four courses used in this evaluation totalled 461. Most students (93%) were single. Of the total population, 37% were employed, working an average of 14 hours per week. The majority of students, having graduated from high school the previous year, were freshmen carrying an average of 14 semester hours.

Most students reported their mean high school grade to be in the B range. High school rank averaged at the 60th percentile (with a standard deviation of 24) and the mean ACT score was 17.3 (with a standard deviation of 5.2).

Approximately 56% of the students who completed the course attended at least one SCI session. Those students who attended SCI averaged close to six sessions each during the semester. The mean course grade was 2.381 on a four point scale and the mean semester GPA was 2.307 on a four point scale.

Results

The data described above were submitted to structural equation analysis to determine the effects of each variable. Because it is necessary to have complete data for each case, a listwise deletion limited the analysis to the 253 cases with comolete data. (Students who added late or dropped the course are not included.) The significant relationships are diagrammed in Figure 3 and Figure 4. While there are many interesting things that emerge from an examination of these figures (particularly relating to the points of divergence from the hypothetical model), the focus of the current paper is on the SCI program. The results will be presented in two sections; factors that affect SCI participation and the effects of SCI participation. First, however, an introduction to the statistical technique is required.

An Introduction to Path Analysis. In structural equation (or path) analysis, standardized regression coefficients, or Betas (represented by ß), show what the impact of one variable on

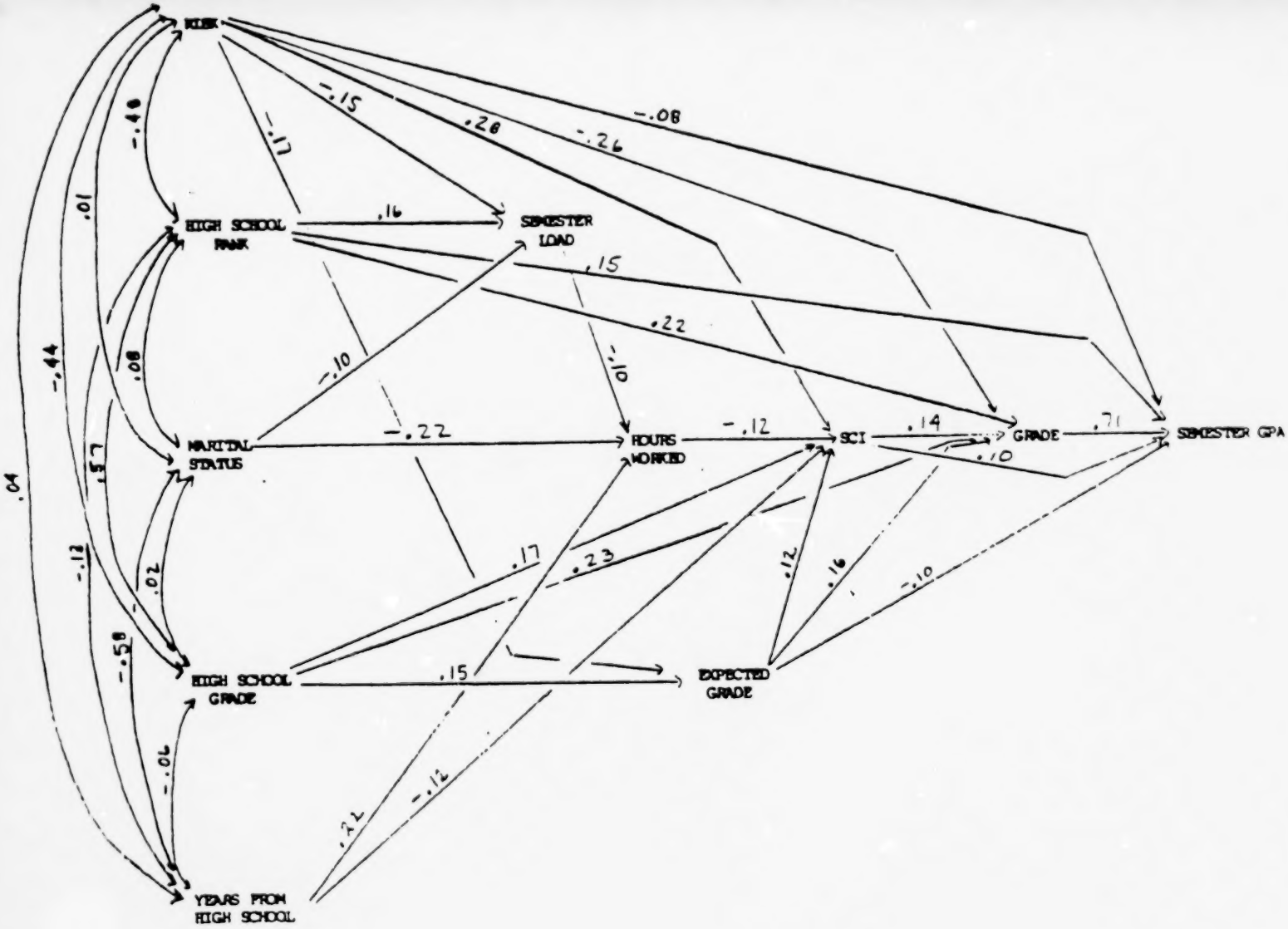
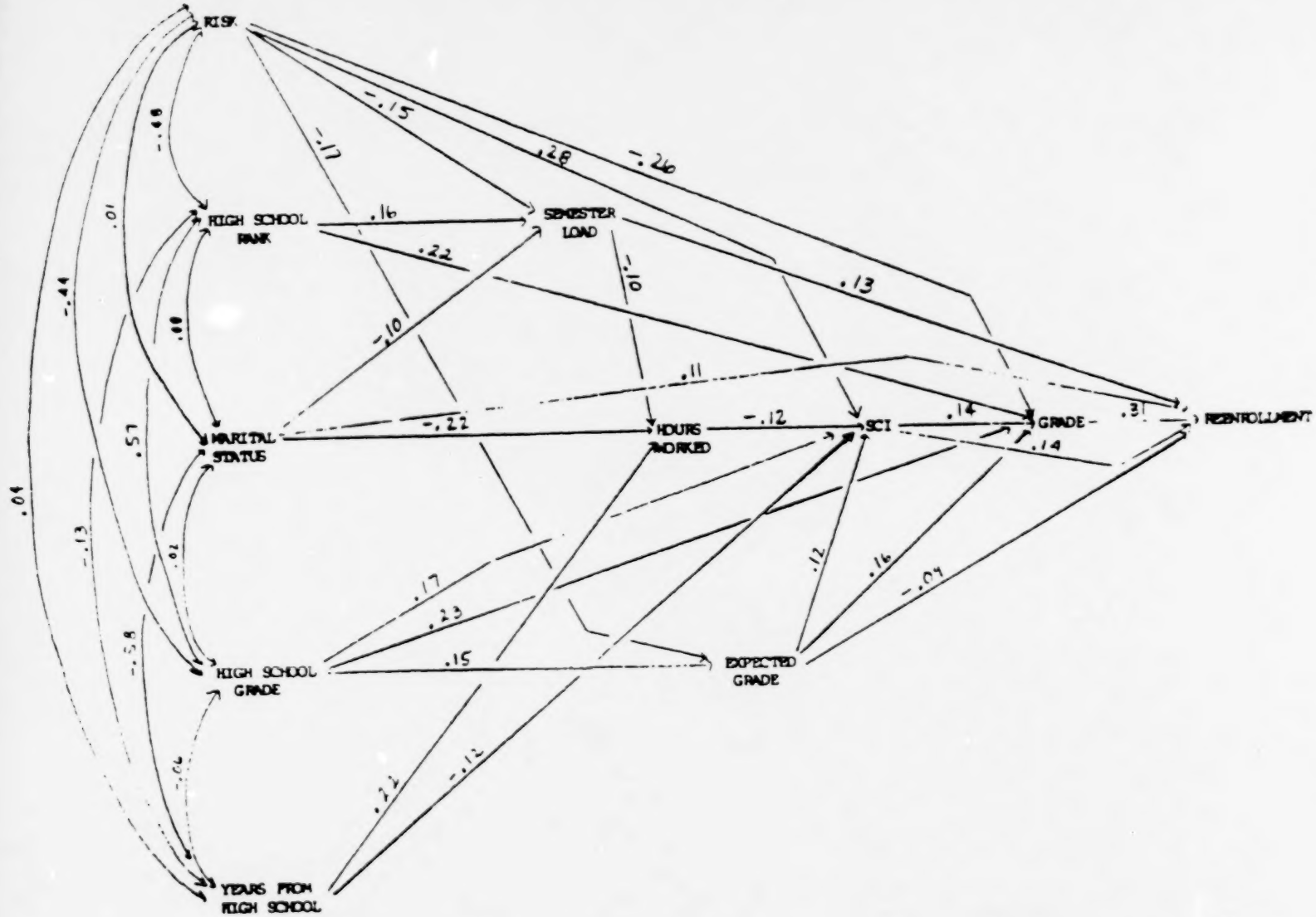

RACE
HIGH SCHOOL RANK
SEMESTER LOAD
MARITAL STATUS
HOURS WORKED
SCI
GRADE
SEMESTER GPA
HIGH SCHOOL GRADE
EXPECTED GRADE
YEARS FROM HIGH SCHOOL
-.08
-.26
.28
-.15
-.17
-.48
.01
.16
.15
.22
-.10
-.10
-.44
.08
.04
-.22
-.12
.14
.71
.10
.57
-.12
.02
.17
.23
.12
.16
-.10
-.58
.15
-.06
.21
-.12

FIGURE 3


RISK
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HIGH SCHOOL GRADE
EXPECTED GRADE
YEARS FROM HIGH SCHOOL
-.15
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-.26
-.17
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.12
.16
-.04
.22
-.12
-.48
.01
-.44
.08
.57
.04
-.13
.01
-.58
-.06

FIGURE 4

another would be if both variables were stated in the same units. Technically, the path coefficients can be read as a percentage of a standard deviation change in the dependent variable that is attributable to the independent variable. The larger the magnitude of the ß, the stronger the effect. Because the variables are all in standard units, their relative effects can be determined. By examining a set of relationships (this is where the notion of model comes in), both direct and indirect effects of independent variables can be examined.

Factors Affecting SCI Participation. Overall, the hypothetical model outlined earlier explained a total of 12.5% of the total variance of SCI participation. While this suggests that there are probably other factors related to SCI participation, there are significant effects (both direct and indirect) of the exogenous and endogenous variables as presented in Table 1.

Table 1
Direct, Indirect, and Total Effects
of Factors Affecting SCI Participation

	DIRECT EFFECT	INDIRECT EFFECT	TOTAL EFFECTS
EXOGENOUS VARIABLES			
RISK	0.280	-0.022	0.258
HIGH SCHOOL RANK	----	0.002	0.002
MARITAL STATUS	----	0.025	0.025
HIGH SCHOOL GRADES	0.170	----	0.170
YEARS SINCE HS	-0.120	-0.026	-0.146
ENDOGENOUS VARIABLES			
SEMESTER LOAD	----	0.012	0.012
HOURS WORKED	-0.120	----	-0.120
EXPECTED GRADE	0.120	----	0.120

Three of the exogenous variables have a direct, statistically significant, impact on SCI participation. The strongest relationship exists between the level of "risk" of the student and SCI (β=0.28). The more the student is under-prepared, at least using this particular measure, the more likely he is to use SCI. On the other hand, there is also a direct positive effect between reported high school grades and SCI participation (β=0.17). "Better" high school students are attracted to SCI as well. The third exogenous variable that is related to SCI participation is years since high school. The longer the student has been out of high school, the less likely he is to use SCI (β=-0.12). Indirect effects on SCI can be seen coming from risk (through semester load and expected grade), high school rank (through semester load), marital status (through hours worked and semester load), and years since high school (through hours worked).

Two endogenous variables also have direct impacts on SCI participation. The more a student works, the less likely he is to attend SCI sessions (β=-0.12). The other important variable is expected grade. Students who expect to do well in the course are significantly more likely (β=0.12) to attend SCI sessions. There is also an indirect effect of semester load (through hours worked).

Background characteristics seem to have the largest relative impacts on SCI participation. While effects of endogenous variables can be observed, these can be seen to "cancel each other out".

Table 2
Direct, Indirect, and Total Effects
of SCI Participation on Course Grade,
Semester GPA, and Reenrollment

	DIRECT EFFECT	INDIRECT EFFECT	TOTAL EFFECTS
DEPENDENT VARIABLES			
COURSE GRADE	0.140	----	0.140
SEMESTER GPA	0.100	0.099	0.199
REENROLLMENT	0.140	0.043	0.183

The Impacts of SCI. As shown in Table 2, participating in SCI had significant direct effects on course grade (B=.14, equation R^2=.426), semester GPA (B=.10, equation R^2=.745), and reenrollment (B=.14, equation R^2=.182). It is important to note that these three effects are all independent of the other factors in the model. In other words, these represent the pure impacts of participation in the SCI program.

In addition, SCI participation is indirectly related to semester GPA and reenrollment due to its relationship to course grade. This indirect effect on GPA is almost as large as the direct effect.

Implications for SCI

Seven main implications can be drawn from our study. Each of these will be considered with more general conclusions following.

1. We found that SCI serves a broad population which confirms our original assumptions about the type of student choosing to attend SCI. It is not seen as <u>just</u> for the remedial or poor student but it is seen by the general population as a means of supplementing course instruction.
2. Time constraints make it difficult for married students to attend SCI study sessions. While married students may comprise a small percent of the population studied, scheduling evening study sessions precludes many from attending. Time management is a greater problem for the older and/or married student and this consideration must be dealt with in scheduling study sessions.
3. Regardless of background, the better a student expects to do in a course the more likely the student is to attend SCI. Students may view SCI as a means to achieving the better grade that they expect. SCI may no longer be considered as an extra but instead as an essential part of the course. Our challenge is to increase the number of students that view SCI in this manner as well as to deliver.

4. As we had hoped, there is a significant, positive impact of SCI on course grade. No matter which risk population, high or low, the student comes from, those which consistently use SCI do see a positive difference in course grade. This means that we can be more aggressive in marketing SCI to the students and faculty at Olivet.

5. The direct effect of SCI on GPA may suggest the transfer of skills learned in the SCI study sessions to other courses. This is somewhat surprising considering that it was suspected that study skills were not being taught all that well. What would happen if we did a better job of teaching study skills in SCI?

6. The direct effect of SCI on reenrollment could be due to a sense of involvement resulting from the small group setting in most of the study sessions. As William Turnbull proposed in the November, 1986 issue of the Journal of Developmental Education, involvement is the key to retention. As Martin et. al. state in their evaluation of supplemental instruction, the higher evaluations often given to professors in courses with SCI may be due to students attributing the benefits of SCI to the professor. This suggests that the image of the professor as caring for the student is translated into a form of interpersonal involvement.

Conclusions

One reason we did this project was to test the feasibility of using structural equation modeling as a program evaluation tool. After examining the SCI program at Olivet, we feel that this technique has some real merit. While there may be some who disagree with the measures used, with the specification of the model, or with the presentation of the results (in that we focused only on SCI), we feel that the benefits of this approach outweigh any complaints against it.

The finding that SCI had a direct benefit on student outcomes was important for two reasons. First, it can be influential in deciding "political" issues inside the university. Because we can demonstrate a real impact of the program, we can protect its future development in terms of continuation and potential expansion. The other reason this was an important finding is that the ONU model for Supplemental Course Instruction is a variant of the UMKC model. Because we use undergraduates rather than graduate students and cannot provide intensive supervision, we were worried about generalizing from the results shown in Blanc et. al.. However, since we can show direct benefits, even given these program variations, we feel confident that our model can continue to be effective in assisting students of all ability levels at being more successful in their college experience.

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